TEST EFFECTIVENESS TREND OBSERVATION

Powered-on Assembly Level Vibration Testing on the Voyager and Galileo Programs

CONCLUSION:

Powered-on vibration has proven an effective process for detecting latent and intermittent defects in electronics assemblies.

INTRODUCTION:

This trend observation TO-0001, Rev. A, replaces a trend observation with the same title released on January 20, 1992. The problem/failure (P/F) data used in the analysis of the original trend observation was reevaluated in con unction with additional information obtained from test-related files.

As a result of this additional information and enhanced technical scrutiny, the original data was examined for implications of the occurrence of each P/F on the effectiveness of powered-on vibration testing. The conclusions are the same as the original trend observation, but the rationale developed in the attached trend observation and data tabulated herein provide a greater level of supportability of the conclusions than in the earlier trend observation.

DISCUSSION:

An extensive review of Problem Failure Reports (PFRs) from the Voyager and Galileo programs has been made to ascertain whether powering and monitoring of electronics assemblies during the vibration test exposure is an effective method of finding potential failures. An attempt has been made to single out those failures which might not have been discovered by merely performing post-test electrical checkouts of the hardware.

A fairly rigorous procedure was followed to arrive at a conclusion about the effectiveness of powered-on vibration. To do this, all PFRs pertaining to the sub ect for each of the two pro ects were reviewed. This amounted to 84 PFRs on Voyager and 20 on Galileo. These numbers are not as disparate at it initially appears because Voyager had approximately three times the number of assemblies as Galileo. The process for evaluating the power-on issue proceeded as follows:

		Voyager	Galileo
1.	Original number of PFR's involved.	84	20

2.	Of the total number of PFR's, how many problems/failures were observed during the powered vibration which would not be evident from simply post-test or between-axes functional checkouts?	44	14
3.	Of the quantity of problems/failures which were detectable only when vibration and powering were applied simultaneously, how many were accepted without redesign/rework?	41	13
4.	The remainder (paragraph 2. minus paragraph 3.) resulted in redesign/rework of the hardware (i.e., caused an effective change to be made).	3	1

	Voyager	Galileo
Percentage of Problems Requiring Powered-On Vibration for Detection	52% (44/84)	70% (14/20)
Percentage of Detected Problems Which Would Have Been Catastrophic if They Occurred in the Mission	7% (3/44)	7% (1/14)

This leads to the conclusion that >50% of electronics problems are only detected if vibration is performed powered-on, and of those detected ≈7% could have catastrophic consequences if not detected and corrected.

The three Voyager and one Galileo failures of paragraph 4. are the ones that make the case for powered vibration. Each of these four incidents resulted in a risk assessment by problem/failure review engineers which implied that if not caught and corrected could have had a "ma or or catastrophic" impact on the mission. None of these four failures was evident after the vibration was stopped. There is no way of knowing if they would have become evident in subsequent testing or otherwise before launch. In any event, there is the definite possibility that had the failures gone undetected by running the vibration tests unpowered, they could eventually have arisen during the mission.

Based on Voyager and Galileo, two recent JPL in-house, Class A pro ects with good discipline and controls, it is concluded that powering and monitoring of electronic assemblies during vibration is an effective and necessary process for detecting some failures, particularly incipient ones, which might otherwise not be found until late in the development program or worse, appear for the first time during the mission.